Name: _____

Chemistry 129 Spring 2017

General Chemistry

Second Examination:

Periodic table is provided.

You may use a calculator.

Show all your work!

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Bonus: _____/2

Total: _____/100

1. (12pts) Consider the following reaction:

$$10\ Al_{(s)} + 6\ NH_4ClO_{4\ (s)} \rightarrow 4\ Al_2O_{3\ (s)} + 2\ AlCl_{3\ (s)} + 12\ H_2O_{\ (g)} + 3\ N_{2\ (g)}$$

Determine the oxidation number of each element. Which element is reduced and which oxidized? Identify the reducing agent and the oxidizing agent.

Reactants		Products	
Element	Oxidation	Element	Oxidation
Al		Al (in Al_2O_3)	
N		Al (in $AlCl_3$)	
H		N	
Cl		H	
O		Cl	
		O (in Al_2O_3)	
		O (in H_2O)	

2. (10pts) The cyanate ion (NCO^-) has three possible Lewis structures.

(a) Draw these three Lewis structures, and assign formal charges to the atoms in each structure.

(b) Which Lewis structure is the preferred one? Why?

3. (18pts) Consider the following molecules: **NO_2, IF_5, ClF_3.**
(i) Draw their Lewis structure, (ii) Determine the electron group and molecular geometries, (iii) Is the molecule polar or nonpolar?

(a) NO_2

Electron Group Geometry: _____
Molecular Geometry: _____
Polar or Nonpolar?: _____
Hybridization of Central Atom: _____

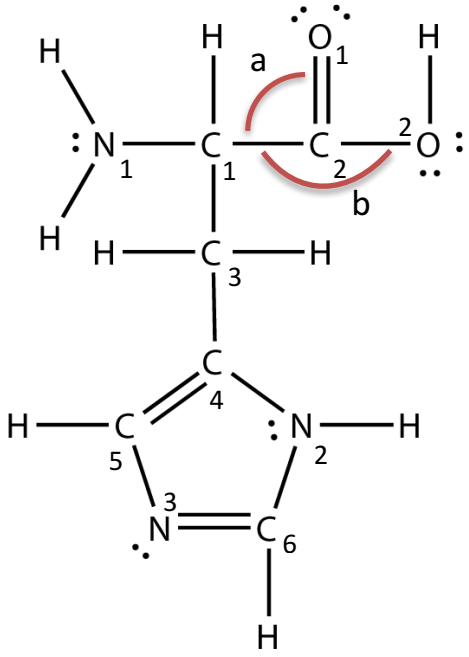
(b) IF_5

Electron Group Geometry: _____
Molecular Geometry: _____
Polar or Nonpolar?: _____
Hybridization of Central Atom: _____

(c) ClF_3

Electron Group Geometry: _____
Molecular Geometry: _____
Polar or Nonpolar?: _____
Hybridization of Central Atom: _____

4. (13pts) (a) What are the hybridizations of the **six carbon**, the **two oxygen**, and **three nitrogen** atoms?



C_1: _____ **C_5:** _____ **N_1:** _____

C_2: _____ **C_6:** _____ **N_2:** _____

C_3: _____ **O_1:** _____ **N_3:** _____

C_4: _____ **O_2:** _____

How many sigma bonds and pi bonds does the molecule have?

_____ sigma bonds _____ pi bonds

(b) Which angle is smaller a or b? Explain.

5. (17pts) Using the molecular orbital energy diagram given below (for **ALL** electrons):

a. (8 pts) **Complete** the molecular orbital energy-level diagram for C_2 and write its electron configuration. **Label** all the atomic orbitals and molecular orbitals. **Sketch** the shape of the σ_{2p} and σ_{2p}* molecular orbitals.

b. (3 pts) Determine the bond order of C_2. Is C_2 paramagnetic or diamagnetic? Why?

c. (6 pts.) If two electrons are added from C_2 to form C_2^{2-}, how many unpaired electrons would C_2^{2-} have? Calculate the bond order of C_2^{2-}. Which would you expect to have a stronger bond, C_2 or C_2^{2-}? Longer bond? Why?

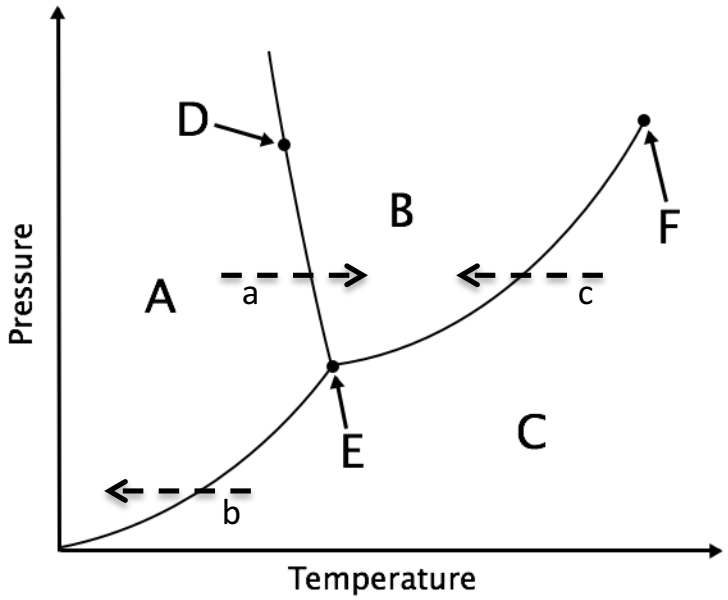
6. (15pts) (a) When NaF dissolves in water, the main force of attraction that exists between F^- and H_2O is called _____.

(b) Hydrogen sulfide (H_2S) is a gas at room temperature. What is the major attractive force that exists among different hydrogen sulfide molecules in the gas?
_____.

(c) Identify intermolecular forces present in each of the following and arrange them in order of **increasing** boiling point: **HCl**, **HF**, and **HBr**. Explain.

(d) Which molecule would you expect to be more soluble in water, CH_2Cl_2 or CCl_4? Why?

7. (15pts) (i) The phase diagram of a hypothetical substance is shown in the following figure. Identify the phase(s) present at points A through F.



A: _____

B: _____

C: _____

D: _____

E: _____

F: _____ (beyond this point)

(ii) Name the phase change shown by the dashed arrows. Is the process endothermic or exothermic?

a. _____

b. _____

c. _____

Bonus: (2 pts)

Arrange the following in order of increasing length. Explain.

Cl—Cl H—H H—Cl